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First LDSD Test Flight a Success

NASA's Low-Density Supersonic Decelerator (LDSD) successfully completed its near-space test flight June 28 off the coast of the U.S. Navy's Pacific Missile Range Facility in Kauai, Hawaii.

A high-altitude balloon launch occurred at 1:45 p.m. CDT from the Hawaiian island facility. At 4:05 p.m. CDT, the LDSD test vehicle dropped away from the balloon as planned and began powered flight. The balloon and test vehicle were about 120,000 feet over the Pacific Ocean

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Hours after the June 28 test of NASA's Low-Density Supersonic Decelerator over the U.S. Navy's Pacific Missile Range, the saucer-shaped test vehicle is lifted aboard the Kahana recovery vessel. (NASA/JPL-Caltech)

NASA Associate Administrator for Space Technology Dr. Michael Gazarik Talks Technology As Tank Testing Gets Underway

By Tracy McMahan

Dr. Michael Gazarik, NASA's associate administrator of the Space Technology Mission Directorate, talked to reporters and team members last week during a visit to NASA's Marshall Space Flight Center. Gazarik visited the new, centralized control room in Marshall's historic East Test Area. The control room is being used for the first time to conduct tests on one of the largest composite rocket fuel tanks ever built.

"We know from decades of work, and certainly the Huntsville area knows, that technology drives exploration," Gazarik said.

Gazarik discussed how advanced

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at the time of the drop. The vehicle splashed down in the ocean at approximately 4:35 p.m. CDT, after the engineering test flight concluded. The test vehicle hardware, black box data recorder and parachute were all recovered later in the day.

"We are thrilled about Saturday's (June 28) test," said Mark Adler, project manager for LDSD at NASA's Jet Propulsion Laboratory. "The test vehicle worked beautifully, and we met all of our flight objectives. We have recovered all the vehicle hardware and data recorders and will be able to apply all of the lessons learned from this information to our future flights."

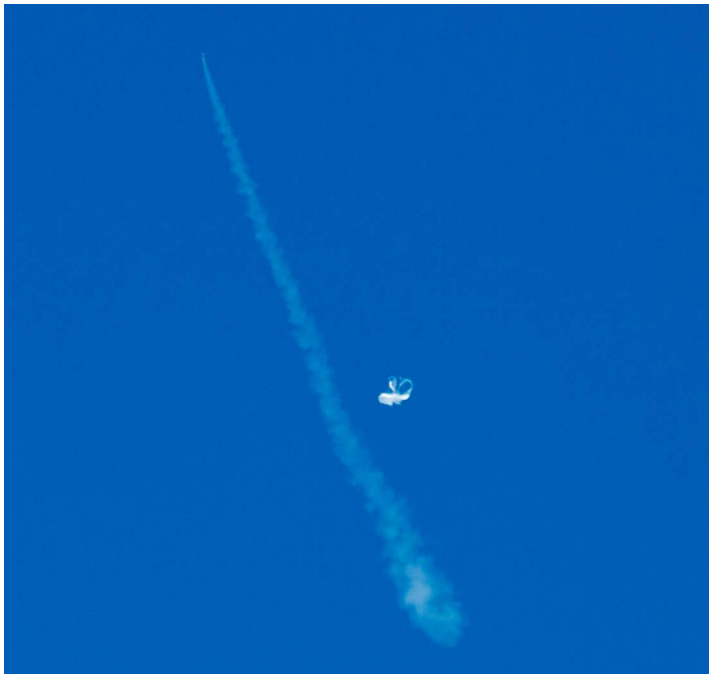
This test was the first of three planned for the LDSD project, developed to evaluate new landing technologies for future Mars missions. While this initial test was designed to determine the flying ability of the vehicle, it also deployed two new landing technologies as a bonus.

"Because our vehicle flew so well, we had the chance to earn 'extra credit' points with the Supersonic Inflatable Aerodynamic Decelerator (SIAD)," said Ian Clark, principal investigator for LDSD at the Jet Propulsion Laboratory. "All indications are that the SIAD deployed flawlessly, and because of that, we got the opportunity to test the second technology, the enormous supersonic parachute, which is almost a year ahead of schedule."

The SIAD is a large, doughnut-shaped first deceleration technology that deployed during the flight. The second is an enormous parachute (the Supersonic Disk Sail Parachute). Imagery downlinked in real-time from the test vehicle indicates that the parachute did not deploy as expected and the team is still analyzing data on the parachute so that lessons learned can be applied for the next test flights scheduled for early next year.

In order to get larger payloads to Mars, and to pave the way for future human explorers, cutting-edge technologies like LDSD are critical. Among other applications, this new space technology will enable delivery of the supplies and materials needed for long-duration missions to the Red Planet.

"This entire effort was just fantastic work by the whole team and is a proud moment for NASA's Space Technology Mission Directorate," said



The LDSD test vehicle is unseen at the tip of the slash-like contrail at the upper left of this image. Just to the right of the contrail, and about a third of the way up, is the balloon that carried the saucer. (NASA/JPL-Caltech)

Dorothy Rasco, deputy associate administrator for the Space Technology Mission Directorate at NASA Headquarters. "This flight reminds us why NASA takes on hard technical problems, and why we test -- to learn and build the tools we will need for the future of space exploration. Technology drives exploration, and yesterday's flight is a perfect example of the type of technologies we are developing to explore our solar system."

NASA's Space Technology Mission Directorate funds the LDSD mission, a cooperative effort led by NASA's Jet Propulsion Laboratory. NASA's Technology Demonstration Mission program manages LDSD at NASA's Marshall Space Flight Center. NASA's Wallops Flight Facility coordinated support with the Pacific Missile Range Facility and provided the balloon systems for the LDSD test.

For more information about the LDSD space technology demonstration mission, visit here.

For more information about the Space Technology Mission Directorate, visit here.

The follow-along page from the media teleconference can be found here.

Gazarik Talks Technology

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technologies, such as composite fuel tanks, landing devices and in-space manufacturing will make future deep space missions not only possible but also more affordable.

The 18-foot-diameter (5.5-meter) composite rocket fuel tank built by the Boeing Co. near Seattle arrived at Marshall on March 26 on NASA's Super Guppy airplane. The tank has just completed its first round of testing and the second round of testing is getting underway. NASA is pursuing composite cryogenic fuel tanks, a potentially gamechanging technology, because the tanks could yield significant cost and weight reductions on future launch vehicles.

"With a test article like this tank, we can take risks that we wouldn't take with flight hardware," said John Vickers, the project manager for the Composite Cryotank and Technologies Demonstration Project at Marshall. "We can try new materials and manufacturing processes and learn more about how to use composites for aerospace and defense missions without adding risks or costs to any of NASA's current projects."

The ultimate goal is to advance composite technology, so tanks are ready as NASA's Space Launch System, the largest most powerful rocket ever built, evolves. The SLS team is already

Dr. Michael Gazarik, NASA's associate administrator for Space Technology, sits in a control seat in the test area at Marshall where the composite cryotank is undergoing testing. Gazarik visited Marshall for an update on tank testing and to see an engineering unit that is identical to a 3-D printer that will soon head to the International Space Station. (NASA/MSFC/Emmett Given)

John Vickers, left, project manager for the composite cryotank project, Dr. Michael Gazarik, center, associate administrator for NASA's Space Technology Mission Directorate, and Niki Werkheiser, right, project manager for the International Space Station 3-D printer, talk about technology projects at Marshall. (NASA/MSFC/Emmett Given)

investigating how additive manufacturing or "3-D" printing can be used to make engine components and other rocket parts. This technology makes almost every phase of NASA missions more affordable, and a 3-D printer will soon demonstrate additive manufacturing in space for the first time.

Gazarik and team members saw a prototype of the 3-D printer that will head to the International Space Station later this year. Marshall engineers just completed testing and certification for the 3-D printer provided by Made In Space Inc., of Mountain View, California. This technology has the potential to enable explorers to print tools wherever they are in the universe.

The composite cryotank and the space station 3-D printer are part of NASA's Game Changing Development Program and Space Technology Mission Directorate, which is innovating, developing, testing and flying hardware for use in NASA's future missions.

For more information about the composite cryogenic fuel tank's arrival aboard NASA's Super Guppy airplane and the tank's testing at Marshall, watch this video.

McMahan is a public affairs officer in the Office of Strategic Analysis & Communications.

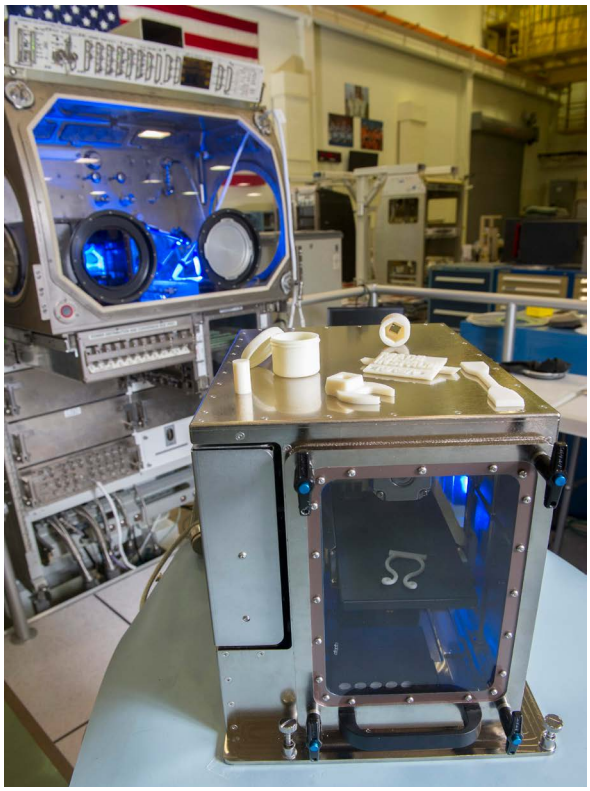
Marshall Center Completes 3-D Printer Tests

A 3-D printer that astronauts call their version of a "Star Trek" replicator has completed a series of tests at NASA's Marshall Space Flight Center, verifying it is ready to be launched to the International Space Station later this year.

In-space additive manufacturing, or 3-D printing, has the potential to revolutionize every aspect of space exploration, from printing small critical parts and tools to the construction of larger structures in space.

The 3-D printer, built by the company Made In Space Inc., of Mountain View, California, was subjected to a battery of tests by Marshall engineers, who verified the hardware meets NASA safety and operational requirements for use aboard the space station.

"The Marshall Center has extensive expertise in additive manufacturing technology and in preparing experiments for launch and operating them on the space station," said Chris Singer, director of Marshall's Engineering Directorate. "Our expertise along with our ability to test payloads in flight-like environments has provided an excellent opportunity for a government and industry partnership to verify that the Made in Space printer was ready to demonstrate this technology for the first time in space."



The 3-D printer technology demonstration payload is undergoing final flight certification testing at Marshall. Designed and built by Made In Space, it will be the first 3-D printer to fly in space. (NASA/MSFC/Emmett Given)

The Made In Space team brought the printer to Marshall in March, and for three months, the printer experienced a shakedown cruise through multiple laboratories. Marshall engineers put the printer through its paces to ensure it could withstand vibrations during launch, verified materials and electronics were safe for station operations, tested it with station systems and ensured humans could operate the printer with ease. Astronauts even tried out the printer at NASA's Johnson Space Center, becoming familiar with the hardware operations as part of astronaut training.

"Throughout our partnership with Made In Space, we have helped prepare the printer to work in an environment that is literally out of this world," said Niki Werkheiser, 3-D print project manager at Marshall. "NASA engineers have a vast amount of experience designing and certifying hardware to operate in space. We were happy to share that knowledge with Made In Space. As a result, the hardware passed testing with flying colors."

The printer extrudes streams of heated plastic, which build layer upon layer out of acrylonitrile butadiene styrene plastic -- the same material used to manufacture Lego® bricks -- to create a three-dimensional object. Testing and operating the printer on the station is the first step toward creating a replicator which will be critical when explorers venture far away from Earth and need tools in remote locations.

"Made In Space has laid out a large, audacious vision for changing space exploration by bringing manufacturing to space," said Jason Dunn, chief technology officer for Made In Space. "We've systematically pursued that vision by testing 3D printing in microgravity on parabolic or 'vomit comet' flights, designing a printer that will operate in low gravity conditions, and now flying our 3D printer to the ISS. Now that testing is complete, we are looking forward to seeing the first parts printed in space."

Once the 3-D printer is installed in the space station's Microgravity Science Glovebox, it will print an initial set of more than 20 demonstration parts, including a planned series of test coupons, parts and tools. These demo items were tested at Marshall inside an identical,

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Orion Spacecraft Taking Shape for First Flight Test

NASA Administrator Charlie Bolden, at podium during a June 18 visit to the Operations and Checkout Building at NASA's Kennedy Space Center, helps mark T-6 months and counting to the launch of the Orion spacecraft on Exploration Flight Test (EFT)-1. From left are Cleon Lacefield, Lockheed Martin Orion Program manager; Mark Geyer, NASA Orion Program manager; Rachel Kraft, NASA public affairs officer; and Kennedy Space Center Director Bob Cabana. Marshall's Flight Programs & Partnerships Office has supported the Orion program and EFT-1 including fabricating more than 300 pieces of EFT-1 flight hardware, and conducting critical structural tests of the Launch Abort System thermal production material. The Launch Abort System, positioned on a tower atop the crew module, activates within milliseconds to propel the crew module to safety in the event of an emergency during launch or climb to orbit. The stage adapter that will connect Orion to a Delta IV rocket for EFT-1 was also designed and built at NASA's Marshall Space Flight Center. For the full story, click here. (NASA/Kim Shiflett)

3-D Printer *Continued from page 4*

ground-based engineering version of the glovebox.

The ground-based engineering team will see immediate imagery of parts printed on the space station via downlinked high-definition video, and will receive parts returned to Earth for detailed ground analyses. This first set of prints will verify the printer and extrusion process in microgravity. By comparing Earth-based and space-based printed objects, NASA will continue to refine 3-D printing technologies for the unique microgravity environment.

Testing of the 3-D printer in microgravity is part of the "3-D Printing in Zero-G Technology Demonstration" project, a joint venture made possible by a Small Business Innovation Research (SBIR) award between Made In Space and the Marshall Center. The highly competitive SBIR program encourages domestic small businesses to engage in federal research/research and development that has the potential and provides the incentive to profit from its commercialization.

The 3-D printer effort is a shared investment between NASA's Human Exploration and Operations Mission Directorate and Space Technology Mission Directorate, which together seek to innovate, develop, test and fly hardware for use in NASA's current and future missions. The project illustrates the agency's commitment to developing, testing and infusing new technologies into ongoing and future exploration efforts, enabling the path to asteroids, the outer planets, Mars and beyond.

United Space Alliance engineer Cynthia Azzarita, left, and Boeing Co. engineer Chen Deng, members of the Human Factors Integration Team at NASA's Johnson Space Center, conduct a "human factors and integration" check of the 3-D printer at Marshall. (NASA/MSFC/Emmett Given)

Galactic Pyrotechnics on Display

A galaxy about 23 million light years away is the site of impressive, ongoing fireworks. Rather than paper, powder and fire, this galactic light show involves a giant black hole, shock waves and vast reservoirs of gas.

This galactic fireworks display is taking place in NGC 4258 (also known as M106), a spiral galaxy like the Milky Way. This galaxy is famous, however, for something that our galaxy doesn't have -- two extra spiral arms that glow in X-ray, optical and radio light. These features, or anomalous arms, are not aligned with the plane of the galaxy, but instead intersect with it.

The anomalous arms are seen in this new composite image of NGC 4258, where X-rays from NASA's Chandra X-ray Observatory are blue, radio data from the National Science Foundation's Karl Jansky Very Large Array are purple, optical data from NASA's Hubble Space Telescope are yellow, and infrared data from NASA's Spitzer Space Telescope are red.

A new study made with Spitzer shows that shock waves, similar to sonic booms from supersonic planes, are heating large amounts of gas -- equivalent to about 10 million suns. What is generating these shock waves? Researchers think that the supermassive black hole at the center of NGC 4258 is producing powerful jets of high-energy particles. These jets strike the disk of the galaxy and generate shock waves. These shock waves, in turn, heat the gas -- composed mainly of hydrogen molecules -- to thousands of degrees.

The Chandra X-ray image reveals huge bubbles of hot gas above and below the plane of the galaxy. These bubbles indicate that much of the gas that was originally in the disk of the galaxy has been heated and ejected into the outer regions by the jets from the black hole.

The ejection of gas from the disk by the jets has important implications for the fate of this galaxy. Researchers estimate that all of the remaining gas will be ejected within the next 300 million years -- very soon on cosmic time scales -- unless it is somehow replenished. Because most of the gas in the disk has already been ejected, less gas is available for new stars to form. Indeed, the researchers used Spitzer data to estimate that stars are forming in the central regions of NGC 4258, at a rate which is about

(X-ray: NASA/CXC/Caltech/P.Ogle et al; Optical: NASA/STScI; IR: NASA/JPL-Caltech; Radio: NSF/NRAO/VLA)

10 times less than in the Milky Way Galaxy.

The European Space Agency's Herschel Space Observatory was used to confirm the estimate from Spitzer data of the low star formation rate in the central regions of NGC 4258. Herschel was also used to make an independent estimate of how much gas remains in the center of the galaxy. After allowing for the large boost in infrared emission caused by the shocks, the researchers found that the gas mass is ten times smaller than had been previously estimated.

Because NGC 4258 is relatively close to Earth, astronomers can study how this black hole is affecting its galaxy in great detail. The supermassive black hole at the center of NGC 4258 is about ten times larger than the one in the Milky Way, and is also consuming material at a faster rate, potentially increasing its impact on the evolution of its host galaxy.

These results were published in the June 20, 2014, issue of The Astrophysical Journal Letters and are available online. The authors are Patrick Ogle, Lauranne Lanz and Philip Appleton from the California Institute of Technology in Pasadena, California.

NASA's Marshall Space Flight Center manages the Chandra program for NASA's Science Mission Directorate. The Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, controls Chandra's science and flight operations.

Marshall Center's Progress on Cryotank and 3-D Printer Featured on NASA-TV

The continued testing of a new composite cryogenic fuel tank design and completed testing of a 3-D printer -- both at the Marshall Space Flight Center -- were featured in the latest edition of "This Week @NASA," a weekly video program broadcast nationwide on NASA-TV and posted online.

Dr. Michael Gazarik, NASA's associate administrator of the Space Technology Mission Directorate, visited the Marshall Center on June 24 for a closer look at these game-changing technologies.

This and previous episodes of This Week @NASA are available for viewing at the NASA-TV YouTube channel.